INSTITUTE OF MINING RESEARCH

UNIVERSITY OF ZIMBABWE Tel: 303211: IMR Tel/Fax: 336418 Fax: (263-4) 336418
P. O. BOX MP 167 Email: imr@science.uz.ac.zw or (263-4) 333407
MOUNT PLEASANT or (263-4) 335249
HARARE, Zimbabwe

OPEN 165

~~CONFIDENTIAL~~ REPORT NO. ~~C819~~

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE MARANGE CHIADZWA DIAMOND PROJECT

PROPONENT: ZIMBABWE MINING DEVELOPMENT CORPORATION

BY

CUTHBERT Z GAMBARA

JULY 2007

Institute of Mining Research in association with the Department of Geography and Environmental Science is a registered EIA Consultant with the Environmental Management Agency

Table of Contents

List of Figures

Executive Summary

The Zimbabwe Mining Development Corporation (ZMDC) was mandated by Government to conduct exploration and subsequent exploitation of the diamond resource in Marange District. In compliance with the Environmental Management Act, ZMDC commissioned the Institute of Mining Research, University of Zimbabwe to carry out an environmental impact assessment of the envisaged project.

The mining and processing activities of the diamond bearing rock does not involve the use of sophisticated equipment nor chemicals. The impacts associated with the project were assessed and the only significant one is that related to evacuation of people that currently live within the demarcated security zone. Exploration work is currently ongoing and the security zone is likely to expand. The ZMDC authorities have committed themselves to ensure that all evacuations will be communicated to the people concerned including the local government and traditional leadership in time and compensation will be commensurate with current standards.

An environmental management plan for the project has been formulated as a result of the assessment of the impacts of the project in terms of social, economic and ecological setting of the project site and also from the aspirations of the affected stakeholders through the public consultation exercise conducted by the eia team.

From a developmental perspective, the project has a potentially massive positive economic impact for the country. Mineral resources are increasingly being looked upon to increase foreign currency earnings of the fiscus in the face of uncertainty in agriculture as a result of unpredictable weather patterns. The project has the full backing of the government as seen through the visit of the Joint Operations Command during the time of compiling this report.

We therefore conclude that the project should be allowed to go ahead but the proponents are advised to adhere to the recommendations in terms of environmental management plan as contained in this report.

1 Introduction

The Zimbabwe Mining Development Corporation (ZMDC) commissioned the Institute of Mining Research (IMR) to conduct an environmental impact assessment for the Chiadzwa diamond mining project in Marange. An environmental baseline study was undertaken in order to make a proper evaluation of the projected impact of the development on the environment and the community. The study was carried out in order to identify and examine the impacts associated with the development of the mining operations on:

1. Local human population;
2. Local land use and overall ecology;
3. Changes to water regimes and land contours;
4. The disposal of mine waste; and
5. Other issues such as security.

The procedure involved conducting on site studies to allow identification of the possible positive and negative impacts to the environment resulting from the proposed project, including both the "natural" and "human" environments. The alternative of not carrying out the mining project (alternative to do nothing) was the reference point throughout the discussions.

1.1 Location of the proposed project

The proposed Chiadzwa diamond mining area is located in Mutare rural district in Manicaland (Figure 1). The site lies in Marange communal area, which is under the jurisdiction of Mutare Rural District Council. The proposed area is estimated to cover a 12 kilometre perimeter zone. Figure 1 shows the general location of the project site. Access to the site is via a 28km dust road off the Mutare-Masvingo road just a kilometre from Hot Springs to the West.

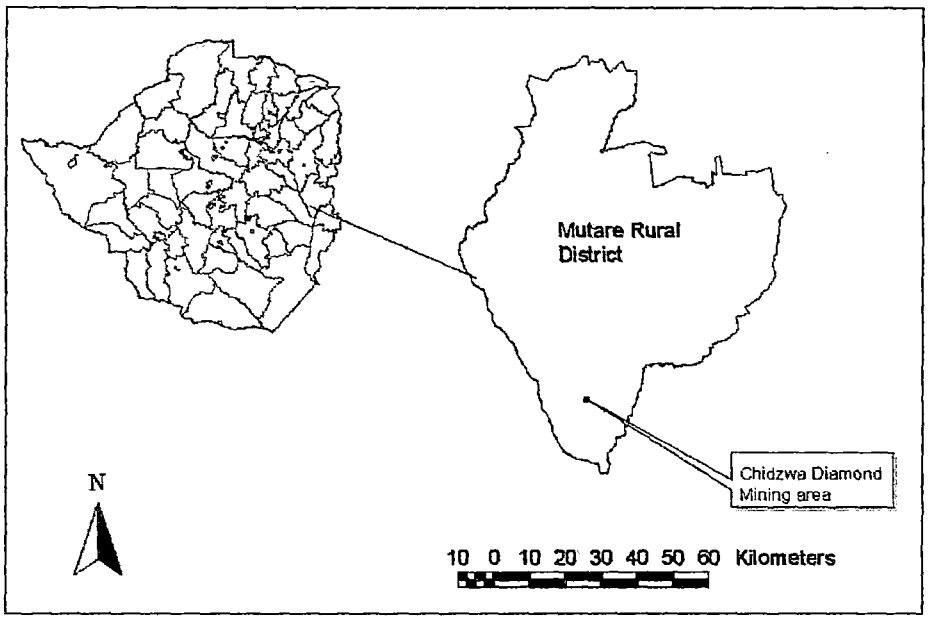


Figure 1: The general location of the Chiadzwa diamond project in Zimbabwe

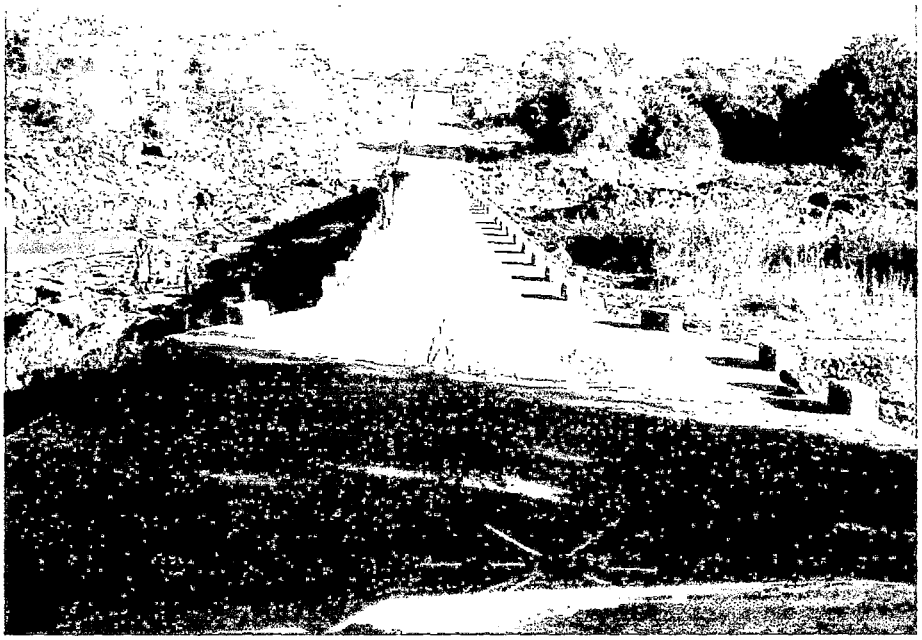


Figure 2 Access Bridge Spanning Across Odzi River

The 28km access road crosses the Odzi River spanned by a narrow bridge (Figure 2) which, will however, need to be upgraded should the project proceed as planned.

2. Background to the Project

2.1 Project Description

The Chiadzwa diamond project is mainly concerned with the mining of diamonds in the 12kilometre zone earmarked for the project by ZMDC. However, prior to the ZMDC takeover, the area had been virtually invaded by both locals and other people from as far as Shurugwi and mining was taking place in a haphazard manner typical of the gold panning syndrome that had characterised Kadoma and Kwekwe. Some of the local populace and foreigners indeed benefited from the illegal mining operations of diamonds at the expense of the environment and government fiscus. Not even the giant baobab trees were spared (see Figure 3 below).

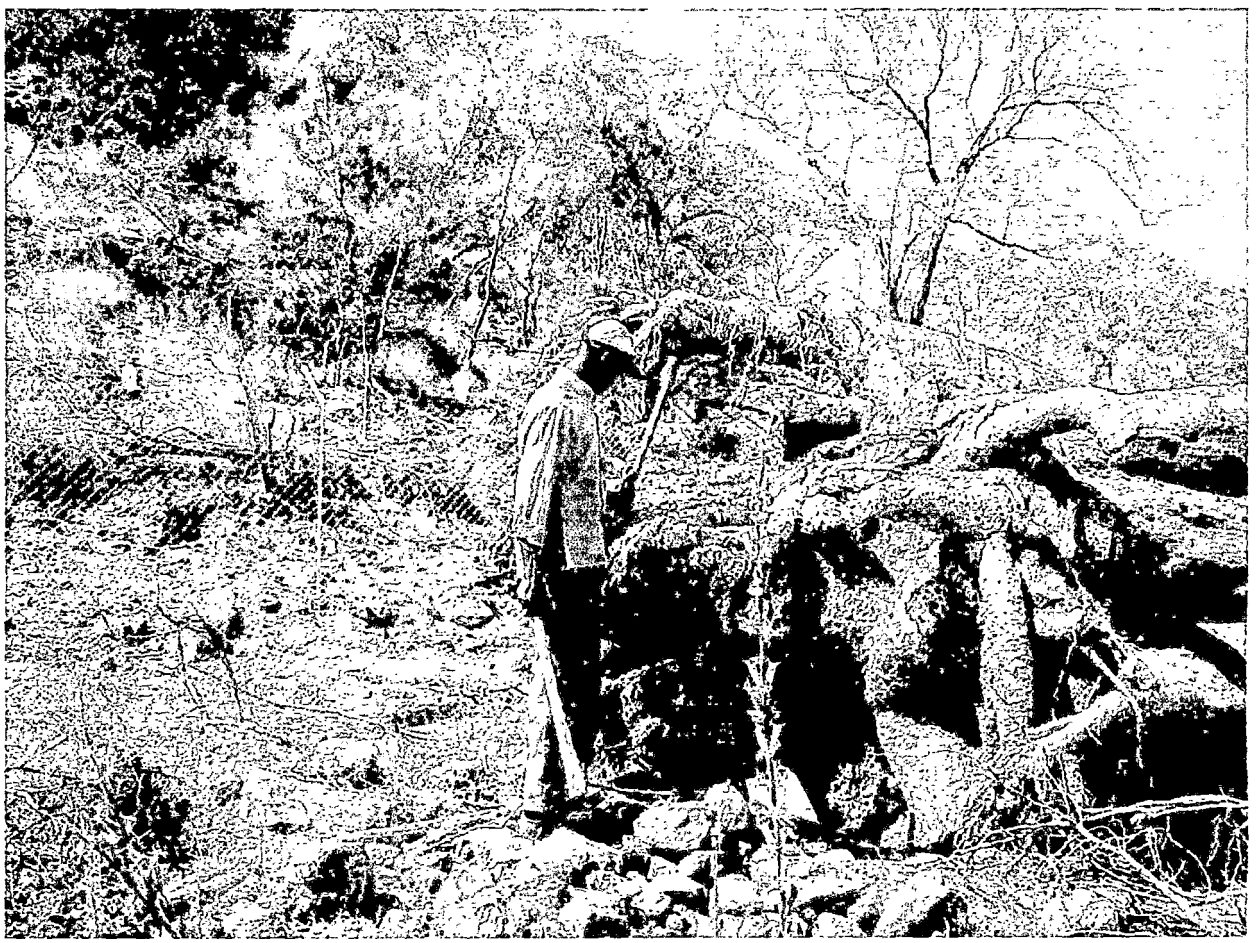


Figure 3 **Baobab: Victim of illegal mining for diamonds**

It is not clear however, how much the Government lost to illegal sale of diamonds as their value could not correctly be established by both the sellers and buyers. It was from the chaos that prevailed that prompted Government to instruct the ZMDC from several other interested parties to conduct mining operations for diamond. Sanity appears to have prevailed in the Marange area following this intervention.

2.2 Mining

Mining will be restricted to excavation of diamond bearing gravel sands and these will be stored for treatment by gravity separation methods. Currently trial mining is being conducted together with exploration work to determine the extent of the diamond bearing agglomerates. It must be noted that the operations are in the meantime exploratory and not full scale production.

2.2.1 Mining Equipment

The mining equipment on site are:

1. 1 x front end loader;
2. 1 x dozer;
3. 1 x back actor;
4. 1 x tractor and trailer;
5. 2 x dump trucks;

2.3 Ore Processing

Ore processing is mainly washing of the concentrated sands having been recovered from a diamond pan.

Figure 4 **Workers waiting to hand sort the diamonds**

There is no specialised processing equipment on site and washing is done using water. No chemicals are used in the processing method and hence no fears from chemical pollution are anticipated.

2.4 Water Supply

Currently domestic and industrial water is being sourced from a borehole that was specifically sunk for the purpose. However, our discussions with the proponents revealed that water supply is inadequate and once the project kicks off from the current pilot stage another source of water will need to be found. The proponent through the Humana Resources Manager, Mr. Makonese indicated that there were plans to draw water from the Odzi River which is, as the crow flies, 14km away from the site. We suggest that a separate environmental impact assessment be done once the plans have been finalised.

2.5 Electricity

There is no electricity at the project site. Currently operations are being run using two diesel powered generators. The proponent will eventually apply for electricity from the Zimbabwe Power Company.

2.6 Human Resources

Currently only 24 employees are engaged at the project. There are 16 security personnel but these are beefed up 298 police details from the Zimbabwe Republic Army. According to the Group Personnel Manager, Mr. Makonese, no houses will be constructed on site for personnel but will be housed in either Mutare, Chipinge or at Nyanyadzi growth point in the now popular fly in fly out practice. A decision is yet to be finalised.

3 Baseline Environmental Information

3.1 The physical and socio-economic setting

The proposed site lies in natural region five, which receives a mean annual rainfall ranging from 400 to 600 mm per year. The soils in the area are generally shallow, sandy loams that are prone to erosion (Nyamapfene, 1991 and Terzaghi and Perk, 1967). The vegetation of the area comprises forest fragments of miombo and mopane woodlands. Granitic boulders and landforms dominate the terrain of the project area.

Like in all communal areas throughout Zimbabwe, most of the land is used for subsistence cropping and livestock husbandry. The main subsistence crops grown include maize, which provides staple food and groundnuts.

3.2 Biophysical surveys

An Aster image with a spatial resolution of 15 by 15 metres acquired on 2 March 2007 was used to extract land cover information. Pre-processing of the acquired image involved correcting for atmospheric effects using the regression method.

Normalised Vegetation Index (NDVI) was calculated using the Aster Image. NDVI was used because it is correlated to green leaf biomass. Chlorophyll, the primary photosynthetic pigments in green plants absorb light primarily from the red and blue portions of the spectrum, while a higher proportion of infrared is reflected or scattered

(Rosenzweig, 1995). NDVI tends to increase with increases in green leaf biomass or leaf area index.

NDVI is calculated using the following formula:

Near-infrared (band 3) – Red (band 2) /Near-infrared band 3) + Red (band 2)

3.3 Vegetation Surveys

In order to ensure that plant species had equal chances of being included on each sampling occasion and avoid misrepresenting vegetation, stratified random sampling method was used. During stratification, vegetation at the project site area was divided into strata (based on observed variation exhibited e.g. type of vegetation, density, and association). Using GIS, random sampling points were then selected from each stratum. In the field, a GPS receiver was used to guide the team to selected sampling points. At each sampling point, a square quadrant (measuring 20*20m) was positioned. To arrive at this optimum quadrant size, we started with the smallest possible quadrant size ($1*1m^2$) usually containing one or two species, doubled its size until no new species were recorded. In each quadrant, the following was carried out:

- identification and measurement of the density of all woody species present;
- measurement of slope angle and elevation using a Suunto clinometer and a GPS

Using the data gathered, Simpson's Index of Diversity (1-D) was calculated. Simpson's Index (D) measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species). There are two versions of the formula for calculating D. With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity. This is neither intuitive nor logical, so to get over this problem, D is often subtracted from 1 to give Simpson's Index of Diversity **1 - D:** The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different species.

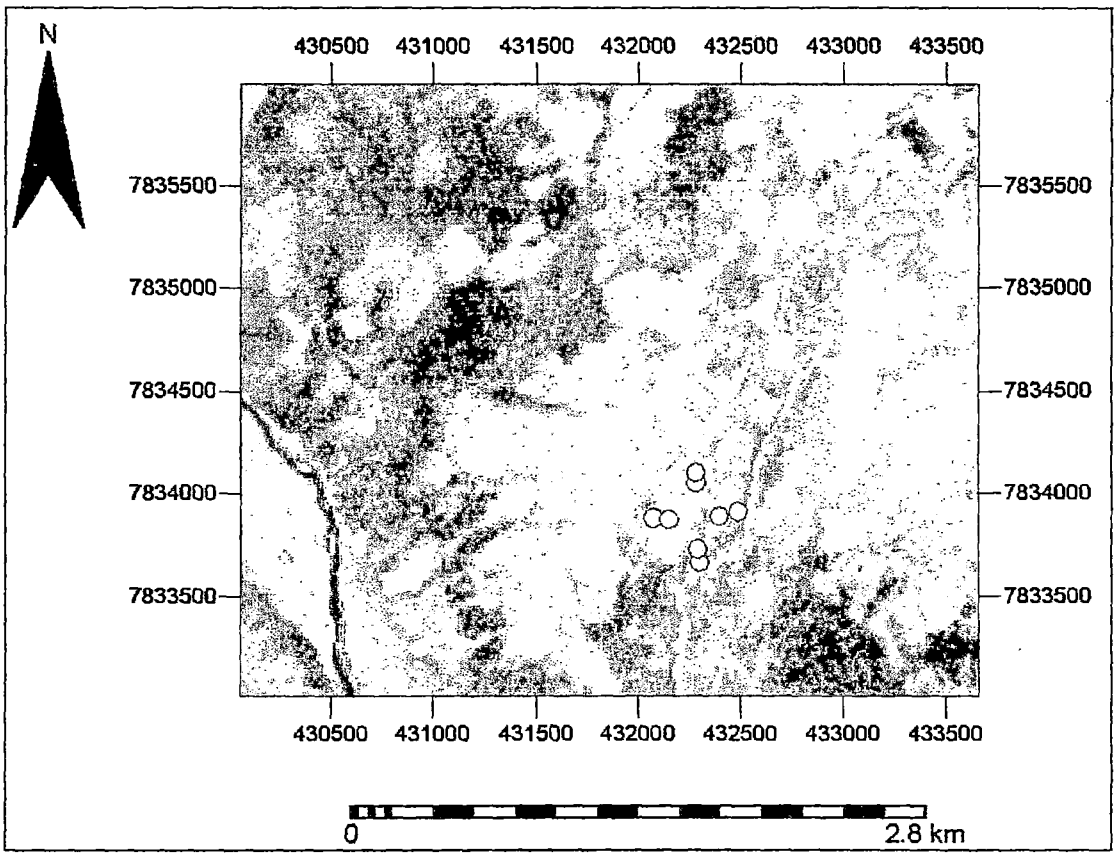


Figure 5: Aster image of Chiadzwa area.

The blue points represent areas where vegetation data was collected

After calculating NDVI and Simpson's Index of diversity a regression model was obtained by regressing the two variables. The regression model was then used to extrapolate for Simpson's diversity in areas where vegetation data was not collected.

3.3.1 Vegetation Species Composition

Marange area is habitat to a twenty one (21) indigenous species (see Table 1) which are likely to be affected by the mining activities in the area. *Combretum apiculatum, Kirkia acuminata, Colophospermum mopane* and *Acacia amythethophylla* are the dominant species.

Table 1: Tree species to be affected by mining activities in Marange

Tree species	*Tree Species*
Acacia amythethophylla	Acacia karoo
Acacia polyacantha	Adansonia digitata
Afzelia quanzensis	Asparagus falcatus
Colophospermum mopane	Combretum apiculatum
Dalbergia melanoxylon	Dichrostachys cinerea
Galbergia melanoxylon	Gardenia spp
Helichrysum nitens	Julbernadia globiflora
Kirkia acuminate	Lannea stuhlmannii
Myrianthus holstii	Strychonos madagascariensis
Ziziphus muchronata	

Tree names obtained from Kwembeya and Takawira

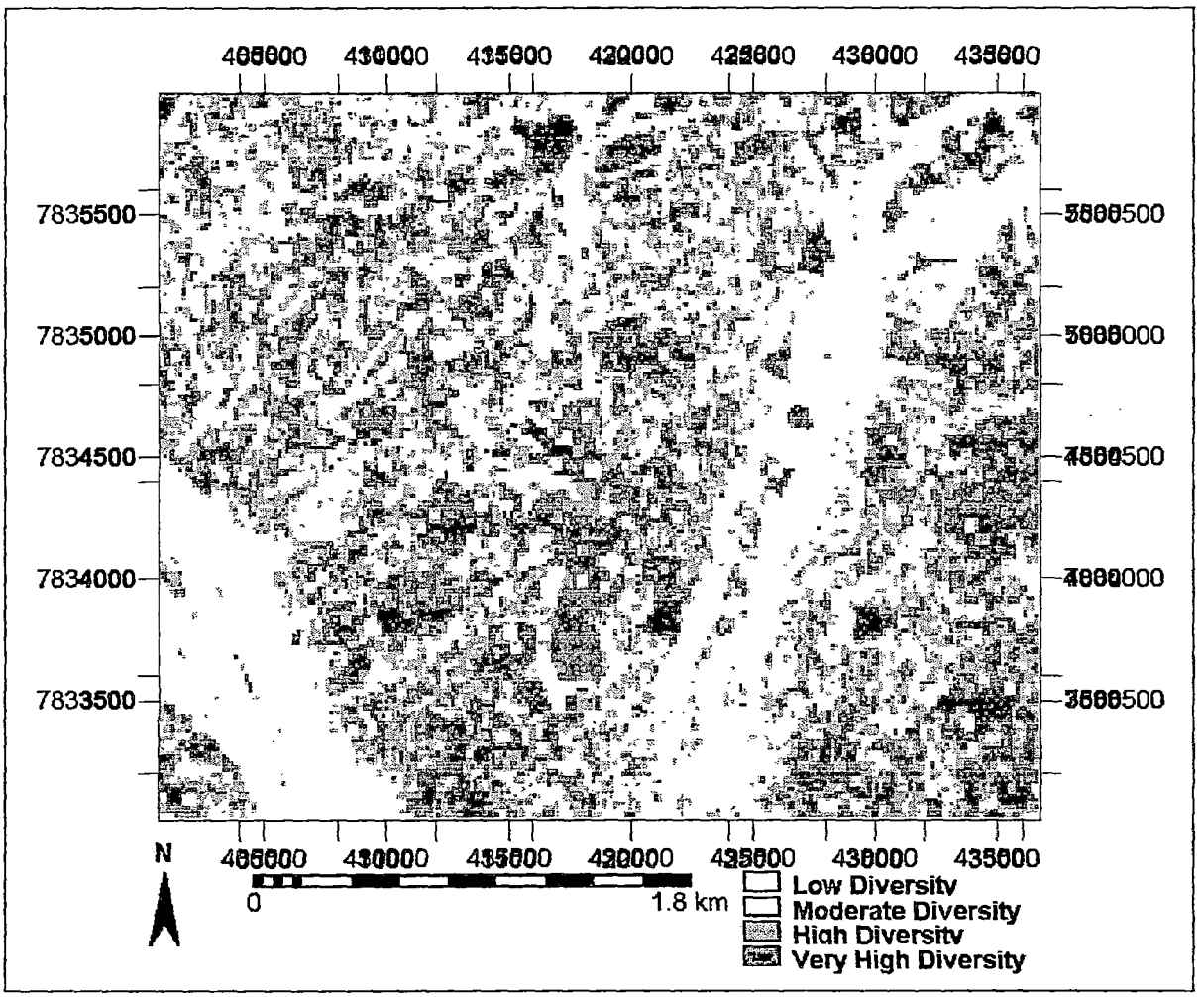
3.3.2 Tree species diversity

Vegetation diversity refers to the variability in vegetation species found in a given geographical area (. In this report Simpson 1-D index of biodiversity was used to quantify tree species diversity in the area. Values near zero corresponding to low tree species diversity or homogeneous ecosystems and values near one corresponds to more heterogeneous ecosystems. Thus the greater the value (index), the higher the tree species variations. Simpson 1-D is calculated as follows:

$$Pi = \frac{Number\ of\ a\ given\ tree\ species}{Total\ number\ of\ trees\ species\ observed} \quad (1)$$

$$Simpson\ D = \sum\left(Pi^2\right) \quad (2)$$

$$Simpson\ 1-D = 1-\sum\left(Pi^2\right) \quad (3)$$



Simpson 1-D index of Marange, divided into 4 quartiles

Tree species diversity (Simpson 1-D) in Marange is generally moderate to very high. Low diversity occurs on the riverbed where vegetation is not expected to grow. Diversity increases away form the river as is shown in the above plate. The mean of Simpson 1-D of the sampled plots is 0.58 which is high with a standard deviation of only 0.13. This indicates that there is not much variation in tree species diversity between sampled points.

3.3.3 Depletion of vegetation cover

Depletion of vegetation will certainly occur during mining operation but since the area to be mined is small the impact is minimal. The tree species in the area are mostly

indigenous and so their removal is less likely to result in the extinction of some of the species.

3.4 Contamination of soil and groundwater

The most likely cause of soil and groundwater contamination on the proposed site is oil spillages and waste from diamond processing. Soil contamination will not be extensive as the processing of diamonds does not require special chemicals like in gold processing. The contamination of groundwater is also going to be limited because diamonds do not react when they come in direct contact with water. In order to mitigate against the negative effects of oil spillages the company is advised to adhere to suggestions contained in this report.

3.5 Noise pollution

Increased levels of noise are likely to occur during the mining operation when heavy machinery is in use. The noise will not negatively impact on the local community since the proposed site is located away from the nearest homesteads. There is also a possibility that people who are closed to the proposed site might be moved therefore noise should not be problem.

4 Relevant Legislation

4.1 The Environmental Management Act (EMA) of 2002

Section 116 of the Environmental Management Act (EMA) of 2002 deals with the conservation and access to biological resources in Zimbabwe. The section points out the need to identify components of biological diversity; prepare and maintain an inventory of the biodiversity of Zimbabwe, and determine actual and potential threats to the bio-diversity and devise such measures as are necessary for preventing, removing or mitigating the effects of those threats (***EMA, 2002***). There is however, a lack of effective implementation of the legislation governing biodiversity components given that the laws and penalties for polluting and degrading the environment are not deterrent enough (***Tsvakwi, 1997; MMET, 1998; Chenje et al., 1998***). Other more recent pieces of legislation to note are listed below.

Statutory Instrument 6 of 2007	Environmental Management (Effluent and Solid Waste Disposal) Regulations, 2007
Statutory Instrument 7 of 2007	Environmental Management (Environmental Impact Assessment and Ecosystems Protection) Regulations, 2007
Statutory Instrument 10 of 2007	Environmental Management (Hazardous Waste Management) Regulations, 2007
Statutory Instrument 12 of 2007	Environmental Management (Hazardous Waste, Pesticides and Other toxic Substances) Regulations, 2007

Some of the penalties to contravening the amendments have since been overtaken by inflation.

4.2 The Forest Act and the Communal Lands Forest Produce Act CLFPA)

With regards to forest biodiversity, the Forest Act and the Communal Lands Forest Produce Act (CLFPA) are the principal pieces of legislation that govern the exploitation of and protection of forest resources in Zimbabwe. Despite post-independence amendments, the two acts largely retain the colonial approach to natural resources management based on racially determined principles (***MMET, 1998, Shumba, 2001***). The CLFPA finds its application in the communal areas that were assigned for the African population. Typically, this act imposes a rather strict regulatory framework, which is highly state interventionist (***Shumba and Marongwe, 2000***). This does not create a sense of forest ownership for communities "living with trees" in the communal areas and consequently such people has no incentive to conserve the adjacent forests (***McGregor, 1991***). On the hand, the Forest Act, whilst seeking to be broad in its

coverage of forest resources throughout the country, finds its primary focus on state forests and on forest resources occurring on private lands, most of which comprise the former European areas (Lawton, 1991).

4.3 The National Biodiversity Strategy and Action Plan (NBSAP)

In 1998, the Ministry of Environment and Tourism prepared its National Biodiversity Strategy and Action Plan (NBSAP). Based on consultations, a number of unmet needs in the conservation and sustainable use of Zimbabwe's biodiversity (which included forestry, wildlife, aquatic life and agriculture) were identified and prioritized (MMET, 1998). The unmet needs included the absence of comprehensive and elaborate biodiversity inventory and monitoring programmes; limited appreciation of the importance and contribution of biodiversity to the national economy and to local communities by policy makers; and inadequate affordable livelihood alternatives to reduce high reliance on natural resources (Shumba and Marongwe, 2000). The specific strategies and plans that were then formulated to address the foregoing unmet needs (the NBSAP) have not yet been comprehensively implemented (Shumba, 2001). Other pieces of legislation are given in the Table below.

4.4 Other Relevant Legislation

Legislation	Type	CAP.	Date	Ministry
Environmental Impact Assessment Policy	Policy		1977	Environment and Tourism
Mines and Minerals Act	Act	21:05	1996	Mines and Mining Development
Mining (Management and Safety) Regulations	SI	109	1990	Mines and Mining Development
Mining (Health and Sanitation) Regulations	SI		1995	Mines and Mining Development
The Parks and Wildlife Act	Act	20:14	1998	Environment and Tourism
Water Act	Act	20:24	1998	Rural Resources and Water Development
Public Health Act	Act	15:09	1996	Health and Child Welfare
Hazardous Substances and Articles Act	Act	322	1961	Health and Child Welfare

5 Public Consultation

5.1 Socio-economic surveys

Archival data on socio-economic issues and human population dynamics, which affect resource demand and utilisation patterns, was collected from sources such as census reports, relevant books, journal articles and government records. Respondents interviewed included the headman of the area, school headmasters and teachers and the local elders.

5.1.1 Stakeholder consultation

Stakeholder consultation involved the following related activities:

- identification of key stakeholders in the project;
- arranging and organising interviews with stakeholder representatives; and
- Discussing stakeholder concerns with project proponents.

The main objective of the public consultation was to ensure that concerns, interests, views, fears and aspirations of key stakeholders are captured in the EIA report. The views of key stakeholders were captured through face-to-face interviews and focus group discussions (FGDs) that were held over a three day period in May 2007. Interviews were held with:

- a village headman representing the local and traditional leadership;
- an elder representing traditional religious beliefs and customs;
- school headmaster and teachers representing the civil service

Two FGDs were held at Zengeni Shopping centre of Chiadzwa communal area and Chakohwa Secondary school. The composition of the FGDs was varied. The first comprised twelve men (12) representing household heads and five (5) women while the second was composed of fifteen (15) teachers representing the interests the civil service.

Figure 6 **Chakohwa Secondary School staff after the FGD**

Figure 7 **Part of FGD for locals after the meeting**

5.2 Description and analysis of Impacts

The proposed mining development is likely to result in a wide range of impacts. The impacts are classified as those affecting the surrounding communities and flora. The potential cultural, socio-economic and biophysical impacts that are likely to occur in the proposed project area are outlined below.

5.2.1 Impacts on people's livelihood systems

5.2.1.1 Employment Creation

The focus group discussions revealed that the area has high rates of unemployment and subsistence farming is the major source of livelihood. The local people felt that the proposed mining project should result in employment creation. In the focus group discussion and the personal interviews conducted around the project site, it was stressed that there is need to ensure that the local people be considered when it came to recruitment of workers for the mine. There was a recommendation that the mining project operates the same way as CAMPFIRE which is done in areas where there is wildlife. During and after establishment phase many outsiders are likely to come seeking to exploit economic opportunities created. This might adversely affect the cultural values of the local community, as some of the behaviour of outsiders is likely to be at variance with theirs. As a way of mitigating against this impact, locals must be given opportunities to take advantage of the new employment and other economic opportunities that are likely to emerge. The Zimbabwe Mining Development Corporation (ZMDC) developer has undertaken to ensure that first preference will be given to the local community in terms of employment. They have also started recruiting former panners in the area. However, in cases where specialised labour is required, labour from other regions will be hired.

5.2.1.2 Economic benefits to local and central governments

Both the local and central governments are likely to benefit from the proposed mining project. The local authority (Mutare district council) will levy the developer for the land allocated for this project. The development of mining will also result in infrastructural development in the area for example construction of roads, provision of electricity and water. This is likely to improve and diversify the revenue base for the council and

strengthen its contribution to socio-economic development. This project will be undertaken by a government company and this means it will directly benefit from the mining operations. The central government is also likely to benefit from value added tax that will be levied on the sale of goods and services at the centre.

5.2.2 Biophysical impacts

5.2.2.1 Aesthetic impacts

The mining operations will result in the clearance of vegetation and the excavation of the ground therefore it is likely to disturb the natural beauty of the area. However, this is unavoidable and mitigation measures have been suggested.

5.2.2.2 Impacts on livestock grazing

The Chiadzwa diamond mining area is an important grazing area for domestic stock especially cattle, goats and sheep. By fencing the area, access to grazing areas in the mountain will be limited. This is likely to be a major cause of concern and there will be tension between the local community and the mining company. In order to minimise potential conflicts with locals, the government should allocate additional land for grazing and pasture.

5.2.2.3 Wood fuel collection

The issue of wood fuel collection in the Chiadzwa area is a sensitive issue since locals do not have alternative sources of wood fuel for use in cooking and heating. Interviews with the local community revealed that they collect firewood from the proposed mining area.
A possible mitigation measure might be to allow the local people to access the felled trees at defined times. Under such an arrangement, locals should be permitted to collect wood fuel from the area on stipulated days of the week. A long term solution though might be lobbying the mining company to electrify the area. Establishing communal woodlots for wood fuel harvesting is also another alternative.

5.3 Other Issues

From the focus group discussions with teachers from two schools Chakohwa and Gandauta Secondary Schools a number of disturbing and positive issues were raised. The negative ones were:

1. An increase in absenteeism from school due the "ngoda" rush;
2. A number of school children marrying (and getting married);
3. An increase in promiscuity among school children;
4. Increase in drunken behaviour;
5. Truancy and a lack of respect for school authorities; and
6. A general disregard of the value of the entire education system.

We were advised that the imposition of the current curfew and movement restrictions had curtailed the behaviour but most thought that intervention strategies were needed to return to normalcy. Some of the teachers wanted to know why the EIA was being done in retrospect and whether the necessary cultural and traditional rituals were done before ZMDC moved into the area.

On the positive side it was reported that overdue fees were paid up and some students bought bicycles and hence reported to school early.

From the public consultation exercise, it became clear that the most important concern that the proponent has to address is that related to the perceptions of the locals in terms of the mining project. Given the type of mining envisaged by ZMDC, there are no significant environmental issues associated with such an operation. Major issues to be addressed are those related to:

1. Relocation of communities in and around the security zone;
2. Compensation and loss of grazing land;
3. Security;
4. Water supply; and
5. Cultural and traditional rituals.

The EIA team has suggested means and ways in which mitigation measures of these and other impacts might be addressed.

We however note from UNEP 1997, that the participation of the affected communities in the decision making process is an essential precondition for a responsible environmental

policy and for avoiding subsequent conflict. Participation is primarily ensured by giving the affected community's access to relevant information at all the stages of the mining activities. The access to information could be realized in two phases. First is the mining operator's duty to disclose certain information to the competent authorities and then the citizen's right to obtain environmental information from the authorities, including information disclosed by the mining operators.

For this operation it would be most appropriate for the proponent to engage both the traditional and political leadership in educating the locals on the merits of the project.

In the light of the foregoing discussion it becomes imperative that a comprehensive Environmental management system be put in place. Such a system should mobilize all the stakeholders at its early inception and identification of significant environmental aspects.

6 Assessment of Environmental Impacts

6.1 Water Resources

The resource that was considered was both ground and surface water. The effects were considered in relation to both constructions, operational and closing down phase of the mine. Of particular concern was the fact that currently the water from the borehole sunk was inadequate to cater even for the pilot project currently underway.

Table 2 Impacts and Effects on Water Resources

Impacts/Effects	Description	Mitigation	Significance
Water shortages for operations	Currently water is being sourced from boreholes sunk for the purpose. The volume of water being pumped in insufficient to cater for the current pilot operations.	The proponent should initiate an environmental impact assessment for drawing water from the Odzi river. This will ensure adequate supply of both domestic and industrial water. Attention should be given to downstream users.	Potentially significant

Contamination of water through spillages such as diesel and oils	Contamination from: 1. Chemicals from plant, workshops, oils and fuel spillage 2. Solid waste disposal sites	All above ground fuel storage facilities shall be bunded to ensure that spillages are contained. All vehicles to be subjected to a planned maintenance regime so as to limit leakages while on the roads. Mine plant and workshops shall have storm drains that flow to the return water dam.	Potentially significant
Disruptions to surface water flow	Rains falling into mining area will not drain into natural water courses	The mining area is not large hence the amount of rain falling on the area is negligible. Indeed the rains falling within the mining area should not be allowed into the environment but directed to a return water dam where oils can be separated.	Not significant
Siltation	Runoff from roads and other infrastructure may cause siltation	There shall be proper road drainage facilities. All water shall be directed to the return water dam or the necessary tools like silk traps shall be erected where necessary.	Not significant
Availability of water to other users	Water will be pumped from Odzi river and this could reduce water available for downstream users	It is as yet to be established whether water abstraction from Odzi will affect downstream users. Further investigations are required	Potentially significant

6.2 Soil and Land Capability

The impact of the project on soil and land capability was limited to the footprint of the project. The impacts were examined in relation to mining area, mine infrastructure, plant area and mine offices. The mine will utilize land in either Mutare, Nyanyadzi or Chipinge but the impacts in relation to housing was not assessed as the decision to implement the fly-in fly-out concept as the norm in new mining developments had not been finalised.

Table 3 Impacts and Effects on Soil and Land Capability

Impacts/Effects	Description	Mitigation	Significance
Loss of grazing land	The demarcation of the 12km perimeter security zone will inevitably result in a loss in grazing land Locals used to fetch firewood and thatching grass from the demarcated zone.	Unfortunately the loss of grazing land is unavoidable given the security concerns of a diamond mining project. The proponent should engage with the local leadership to find an amicable solution.	Potentially significant
There is a possibility of soil pollution from diesel and oils.	Poorly maintained machinery tends to leak oils. Leakages from storages facilities may pollute the soil if not managed efficiently.	All machinery shall be subjected to a thorough planned maintenance regime. All storage facilities shall be constructed in such a manner that all leakages and wash water are directed to a common oil water separator where oils will be recovered.	Potentially significant

Loss of agricultural Land or other land-use	Mining is a competitor in terms of land use	The after mining land use option should be crafted together with stakeholders to ensure maximum benefit	Not significant
Land Clearing and Risk of soil erosion	The development of infrastructure will entail clearing of vegetation which may result in soil erosion	Ensure that removal of vegetation is limited to that which is necessary for the project	Not significant
Use of top soil for mine rehabilitation	All rehabilitated areas will need to be capped with top soil to encourage vegetation growth	Use top soil from the mine for rehabilitation. Avoid creation of borrow pits. Top soil need to be carefully stripped and stockpiled for later use	Not significant
Stimulation of agro-business	A ready market for agricultural products will be created by the mine. Farmers around have the opportunity to sell their produce to the mine		Potentially significant (positive impact)

6.3 Air Quality, Noise and Vibrations

The effects of atmospheric discharges as a result of the project have been arrived at from an assessment whose spatial scope included:

1. effects of construction dust on receptors centred on the construction sites;
2. effects of air quality due to increased traffic;

Table 4 Impacts on Air Quality, Noise and Vibration

Impacts/Effects	Description	Mitigation	Significance
Noise and vibration from increased traffic	There will be an increase in the noise level due to the operations.	Noise from moving machinery and associated vibration is not avoidable and is not likely to exceed 90dB with the exception of the crusher unit which is as yet to be installed	Not Significant
Dust due to increase in traffic	Dust may affect the normal respiratory cycle in vegetation and is generally a nuisance to workers apart from the associated health problems	Dust emanating from increased traffic can be controlled by ensuring that all roads are routinely watered down.	Not significant

6.4 Health and Safety

Health and safety impacts of the project were assessed in terms of the entire project from construction to decommissioning. Recommendations made are meant to ensure that there will be no adverse health effects on the community and mining personnel.

Table 5 Impacts and Effects on Health and Safety

Effects/Impacts	Description	Mitigation	Significance
Increase in Traffic	The project site is remote and hence an increase in traffic in relatively poor roads may result in an increase in traffic accidents	There must be a deliberate driver training exercise to ensure that all drivers are of sober habits. Golden rules for vehicle usage including pre-and post shift checks should be strictly adhered to. Adequate road signs should be installed and speed limits in the rural roads set.	Significant
Possibility of mine related Accidents	Mining is associated with inherent dangers and hence appropriate measures should be put in place	All operations will be conducted as per mine standards, standing instructions and in adherence to the Mining Management and Safety Regulations, 1990	Not significant

6.5 Utilities

Effects on utilities have been assessed for both construction and operational phases of the project.

Table 6 Impacts Associated with Use of Utilities

Impacts/Effects	Description	Mitigation	Significance
Water Shortages	The project intends to source water from the Odzi river. Such action may lead to erratic water supplies for downstream users.	The proponent should engage the relevant stakeholders and Zinwa to find an amicable solution through a separate EIA.	Potentially significant
Solid Waste Disposal	Solid waste likely to be generated are household waste, construction, commercial, maintenance and industrial waste	Environmentally friendly and proved solid waste disposal methods shall be used	Not significant
Communication	There could be a negative impact if communication lines in terms of phones are not established at the mine	Discussions with utility suppliers should be initiated	Not significant

7.6 Socio-Economic Impacts

The assessment of socio-economic impacts was restricted to the project footprint, the settlement camp and the surrounding community being derived from the public consultation exercise. At this stage however, the camp site has not been finalised.

Table 7 Socio-Economic Impacts

Impacts/Effects	Description	Mitigation	Significance
Cultural invasion	Immigration of relatively affluent labour with cash to spend may lead into various vices including prostitution within the local population.	Such a scenario has become common in mining locations. However, management should come up with strategies that educate employees on morality, ethics and issues on STIs, HIV and AIDS. The number of employees expected from outside the region is few.	Significant
Relocation of inhabitants within the mining security zone	The operation may need to relocate people who might be living within the boundaries of the mining site and security zone	Relocation of people inherently involves mistrust and misgivings. The proponent should consult heavily with the stakeholders including the traditional leadership to ensure that the exercise is carried out in a transparent manner and compensation should be commensurate with current standards. Land for relocation should be sourced in consultation with the relevant authorities.	Significant

Employment opportunities	The operation will require unskilled labour.	The proponent is advised to be an equal opportunity employer, genders sensitive with a bias towards locals. This not only diffuses tension between the locals and the proponent but creates a sense of trust between the two.	Significant
Health and Sanitation	Any construction activity requires that adequate health and sanitary facilities are in place.	Health and sanitation issues must be addressed with the assistance of an environmental health officer. Identify a clinic at a nearby health centre and upgrade to mine requirements.	Significant
Communication	The opening up of the area in terms of transport and communication may lead as earlier stated to cultural invasion resulting in all sorts of social conflicts.	This however, is unavoidable. On a positive note communication will mean that the community will readily access information and goods from outside the region.	Significant (Positive)
Supply of goods and services	Goods and services supplied to the mine from outside the district infringes on the development of the district.	The proponent is advised to buy locally whenever it is possible to do so.	Significant
Step migration and promiscuity	Local female population may be attracted to the male workers	Liase with local authorities to contain promiscuity Provide necessary education on desirable behaviour and social	Potentially significant

	Men usually requires that their spouses live with them thus resulting in step migration	responsibility Examine ways in which employees interact with their families However, since employees will not be living at the mine promiscuity may not necessarily be within the Chiadzwa community.	
Truancy in School Children	The diamond rush resulted in children abandoning school, some getting married, others ridiculing teachers on their salaries and general misbehaviour	The Ministry of Education Youth Sports and Culture to initiate training workshops in secondary schools around the area emphasizing the need for an educated society. Schools psychologists may also need to be deployed in the area to rekindle interest in education among secondary school children	Potentially significant

7 Environmental Management Plan

Based on the impact analysis given in the tables above, an environmental management plan (EMP) has been formulated to implement the mitigation measures identified and at the same time enhance the positive impacts of the project. The development of the EMP takes into cognizance a number of criteria:

1 precedents set by similar operations;
2 effectiveness of different practical solutions;
3 feasibility of constructing and operating the mitigatory measures; and
4 Additional costs associated with the implementation of these measures.

The success of an EMP basically depends upon the method employed, the knowledge of the implementing team and the awareness in terms of environmental management in the entire workforce. In essence the tenets behind an EMP are enshrined within an integrated approach in the utilization, planning, maintenance, control and development of an environmental agenda within a project cycle.

Table 8 EMP for Water Resources

Issue	**Procedure**	**Implementing Agency**	**Monitoring Agency**
Water abstraction from Odzi river	Water abstraction should be done after an eia has been done and all relevant stakeholders consulted.	ZMDC	EMA
Water pollution from fuels and oils	All fuel, oil and chemical storage facilities shall be bunded. Each bund wall shall have an outlet with a valve that shall remain in a closed position. Such outlets should lead to an oil/water separator from where used oils shall be recovered and sent to used oil vendors (See Figure 8).	ZMDC	Ministry of Mines Mine Ventilation and Environmental Control Centre Office of the Assistant Chief Mining Engineer Gweru

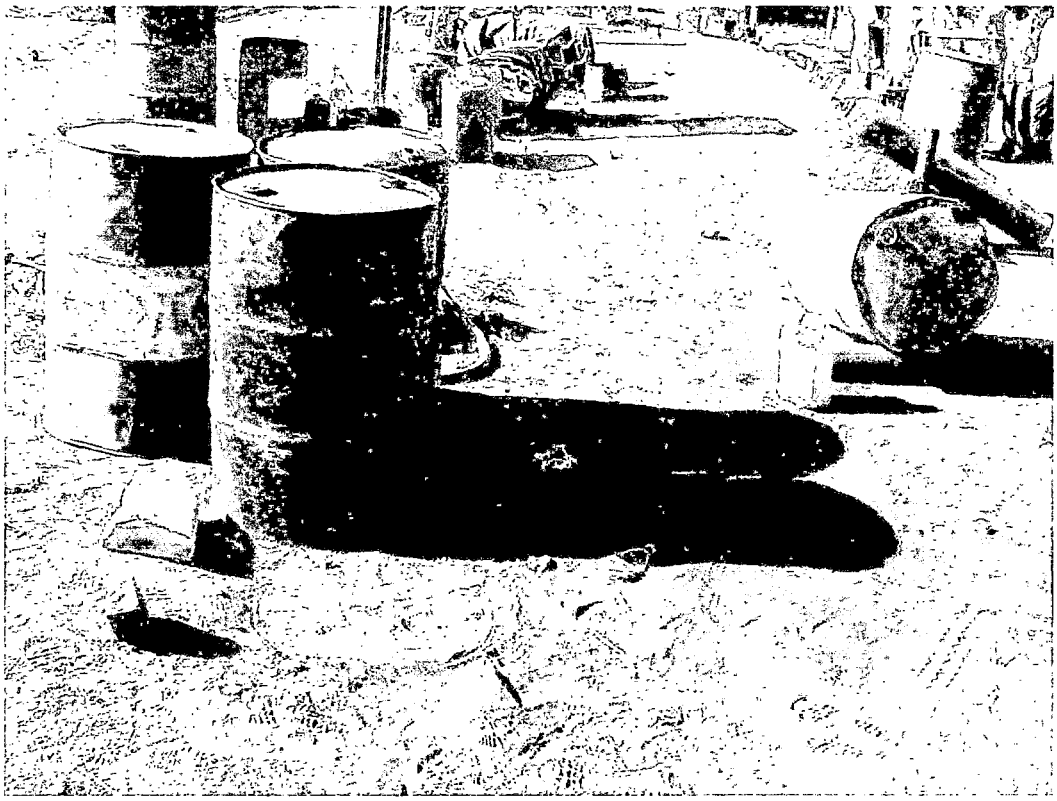


Figure 8 **Oil Spillages that may result in both water and soil pollution**

Table 9 **EMP for Soil and Land Capability**

Issue	Procedure	Implementing Agency	Monitoring Agency
Loss of grazing land	Whilst it is inevitable that some of the land will be lost to its current use, the proponent is advised to seek dialogue with the traditional leadership so seek alternative land for pastures. JOC should be approached for assistance	ZMDC	Headman Chiadzwa, Mutare Rural District Council, JOC
Soil	All oil contaminated waste to	ZMDC	ZMDC

Contamination from indiscriminate disposal of waste oils other waste	be disposed off appropriately in a place specifically designed for that purpose. Avoid environmentally unfriendly handling of oils as in Figure 8.		
Use of top soil	Use soil material from the mine for rehabilitation. Avoid borrow pits	ZMDC	ZMDC
Stimulation of agro-business	Agriculture particularly green gardens can be stimulated if the mine management decides to provide food for employees at the mine.	ZMDC	ZMDC
Land Clearing and Risk of Soil Erosion	Minimize vegetation clearing and erect erosion control structures where necessary, re-habilitate areas no longer required for mining	ZMDC	ZMDC

Table 10 EMP for Air Quality

Issue	**Procedure**	**Implementing Agency**	**Monitoring Agency**
Noise from traffic and moving machinery	All vehicles will be maintained to ensure that they do not produce excessive noise pollution. It must, however, be borne in mind that noise is part of any mining operation through the release of various forms of energy.	ZMDC	ZMDC

Dust from the operations and traffic	Dust from traffic will be controlled by watering down the roads. Mine operators will be issued with the necessary dust protection equipment	ZMDC	ZMDC
Odours from landfill sites	All landfill sites shall be designed as per instruction from the environmental health office. All solid waste shall be disposed off in an appropriate manner. Avoid indiscriminate disposal of waste (See Figure 9).	ZMDC	Environmental Health office Ministry of Health

Figure 9 **Indiscriminate Waste Disposal**

Table 11 **EMP for Health and Safety**

Issue	Procedure	Implementing Agency	Monitoring Agency
Traffic Accidents	Ensure all drivers adhere to the set golden rules and to stipulated speed limits.	ZMDC	ZMDC
Mine Accidents	All mining activities to adhere to the Mining (Management and Safety) Regulations 1990	ZMDC	Office of the Regional Mining Engineer, Harare
Availability of Health Care	Upgrade nearby clinic to mine requirements and	ZMDC	ZMDC

	ensure rapid access to referral hospital in case of emergencies and serious cases		
Dust from mining and other operations, Noise and vibrations from machinery	Workers to be provided with dust masks and ear protection	ZMDC	Office of the Regional Mining Engineer, NSSA

Table 12 EMP for Utilities Usage

Issue	Procedure	Implementing Agency	Monitoring Agency
Electricity	In order to use electricity efficiently a switch off switches policy shall be adopted	ZMDC	ZMDC
Water Usage	A policy to recycle water shall be adopted at the mine	ZMDC	ZMDC

Table 13 EMP for Socio-Economic Impacts

Issue	Procedure	Implementing Agency	Monitoring Agency
Local Benefits	Complement current capacity	ZMDC,	Ministry of Local

	building efforts of local authorities.	Mutare Rural District Council	Government
Cultural Guidance	The traditional leadership should be consulted for organizing cleansing ceremonies and biras	ZMDC, traditional leaders, JOC	Chief Marange
AIDS and other health Issues	AIDS awareness programmes to all workers	ZMDC	Ministry of Health
Working Hours	Each employee shall work the required 8 hours a day unless appropriate breaks and other provisions are applied to extend the working hours	ZMDC	Ministry of Labour and Social Services
Exist Strategy	This report contains a closure plan as appendix 1. However, the document should be viewed as a live document that needs to be updated throughout the life of the operations.	ZMDC, Institute of Mining Research	Office of the Regional Mining Engineer, Harare, Office of the Assistant Chief Mining Engineer, Gweru.
Gender Sensitivity	Employment conditions to adhere to current labour practice. The mine to be an equal opportunity employer. Appropriate facilities for women on mine to be planned for e.g. toilets, changing facilities, protective clothing etc.	ZMDC	ZMDC
Labour Relations	ZMDC to abide by national and international labour laws	ZMDC	Ministry of Labour
Step Migration	Mine to ensure that spouses live	ZMDC	ZMDC

and Promiscuity	together Organize social events in which mine employees and families interact There must be a provision for a education on desirable behaviour and social responsibility		
Truancy	Facilitate workshops on value of education, value of proper mining and marketing of diamonds to the nation	ZMDC, Ministry of Education Sports and Culture	Ministry of Education Sports and Culture

Table 14 EMP for Ecological Resources

Issue	Procedure	Implementing Agency	Monitoring Agency
Loss of vegetation	Minimize habitat destruction. Only clear areas required for infrastructure only	ZMDC	ZMDC
Alien Species	Rehabilitation should be done using indigenous plants only	ZMDC	EMA
Landscaping	Landscaping and planting of shade trees and hedges and screening trees to be done around the mine offices and plant	ZMDC	ZMDC

8 Economic Evaluation

The economic value of the Chiadzwa diamond mining project is enormous once the project has commenced. Presently in Zimbabwe diamonds are being mined from Murowa and a few exploration companies are currently assessing their projects. This precious metal once marketed correctly has the potential to improve not only the livelihoods of Chiadzwa people but the nation as a whole. From the Government perspective, the importance it attaches to the project has been reflected through the constant visits of the Joint Operations Command (JOC) to Chiadzwa to ensure that ZMDC operations resume without any artificial setbacks (See Figure 10 below).

Figure 10 ZMDC's Mr. Mubaiwa addressing members of JOC

References

Chenje, M., Sola, L., and Paleczny, D.,(Eds) (1998), The State of Zimbabwe's Environment. Government of Zimbabwe, Ministry of Environment and Tourism, Harare.

FAO. (1995) State of the World's Forests. FAO, Rome, Italy.

Kwembeya, G. and Takawira, R. A Checklist of Zimbabwean Vernacular Plant Names, National Herbarium and Botanic Garden, Harare.

Kuyek, J and Coumans, C. (2003), No Rock Unturned: Revitalising the economies of Mining Dependent Communities. Mining watch Canada (Online): http://www.miningwatch.ca/

Lawton, R. M. (1988) Natural Resources of Miombo Woodland and Land Use Practices. Forest Ecology and Management. 4 pp. 287 – 297.

Nyamapfeni, G. (1991) Soils of Zimbabwe, Nehanda Publishing Company, Harare

Miranda,M.A., Hernandez, J.,Ochoa ,G.,Yerena,E.(1998), All that glitters is not gold: Balancing conservation and development in Venezuela's frontier forests, World resources institute: Washington,DC.

Murwira, A. (2003) Scale Matters: A New Approach to Quantify Spatial Heterogeneity for Predicting Distribution of Wildlife. PhD Thesis, ITC, Netherlands.

Nyamapfene, K. (1991) Soils of Zimbabwe. Nehanda Publishers, Harare.

Redwood, J. (1998), Social Benefits and Costs of Mining: The Carajas Iron ore project, In G.McMahon (Ed) Mining and the Community: Results of the Quito Conference, Washington, DC The World Bank, 1998.

Rosenzweig, M.L. (1995) Species diversity in Space and Time, Cambridge University Press, New York.

Shumba, E. M. and Marongwe, D. (2000) The Convention on Biological Diversity: An Overview and Lessons Learnt from the Zimbabwean Experience. International Forestry Review 2(2).

Terzaghi, K. and Peck, R. B. (1967) Soil mechanics in Engineering Practice, John Wiley and Sons, New York.

APPENDIX A: MINE CLOSURE PLANNING

1 INTRODUCTION

This part has been included as an addition to the EIA report for Marange diamond mine project. The authors recognize that mining is a finite activity and hence operations are bound to cease once resources have been exhausted. This report therefore addresses issues pertaining to such closure.

1.1 Objective

The main objective of this closure plan is to ensure the incorporation of both physical rehabilitation and socio-economic stability into the mine cycle in order to ascertain that:

1. Future public health and safety are not compromised;
2. Environmental resources are not subject to physical and chemical deterioration;
3. The after-use of the site is beneficial and sustainable in the long term;
4. Any adverse socio-economic impacts are minimised;
5. All socio-economic benefits are maximised; and
6. Adequate resources are allocated for mine closure.

1.2 Legal Requirements

Presently, no legal instruments exist that require the submission of mine closure plans to mining authorities. However, the Mines and Minerals Act chapter 21:05 section 269 and 273 deals with issues pertaining to some aspects of mine closure, the issuance of quittance certificates and submission of mine survey plans. The issues of submission of survey plans and notification of intention to close down a mine are further articulated in the Mining (Management and Safety) Regulations, 1990 section 86 (1) and 86 (2). The Environmental Management Act Chapter 20:27 deals with the requirement for environmental impacts assessment for mining projects (section 97). Whilst closure plans per se are not mentioned in the Act, any environmental impact assessment for a mining project would make provisions for mine closure.

2 Envisaged Closure scenario

The envisaged mine closure scenario is divided into three stages:

1. The Planning Stage: Rehabilitation of site should be integrated into both the mine plan and the environmental management plan.
2. The active care stage: This programme is the one that follows immediately after cessation of a particular activity. Progressive rehabilitation of worked out areas is the best example here.
3. The Passive Care Stage: This activity will follow the decommissioning of the entire site. This is entirely a period of sampling and monitoring designed to demonstrate that all closure scenarios have been successful and hence a walk away state is attainable.

3 The Mine Closure Planning Guideline

This section has been included in the report in order to give guidance as to requirements for mine closure being broken down into key operating business units.

Table 2: Open Pit Workings

ISSUES	OBJECTIVES	CONTROL	RESOURCES
Physical Stability Steep slopes Unstable faces Erosion Safety hydrology	Stable surfaces Removal of hazards Control of erosion Clean water	Re-contour Establish vegetation Control erosion Bunding Install drainage	This should be part of the mining plan and hence should be integrated into the day to day running of the operation
Land Use productivity visual impacts drainage	Restore to original or acceptable alternative use Re-establish drainage patterns	Ensure safe access to bottom of pit	
Chemical Stability metal leaching acid mine drainage (amd)	Clean water Meeting water quality standards	Due to the geology of the host rock amd and metal	Resources will be required for water

		leaching is not expected, however, monitor for AMD	monitoring as part of the passive care stage of mine closure

Table 3: Waste Rock Dump

ISSUES	OBJECTIVES	CONTROL	RESOURCES
Physical stability steep slopes unstable faces erosion drainage dust	stable surfaces avoid failure, slumps and sediment release avoid loose rock falling down slopes	site selection internal drains gentle slopes contour surfaces provide safety ditches establish vegetation monitor dump movement	Site selection is the most important aspect of waste rock as it reduces issues for monitoring. The resources should be taken care of in the initial stages of dump design.
Chemical Stability metal leaching AMD contaminants	Clean water	dump design control drainage and monitor AMD and chemical contaminants particularly mercury.	Experience has shown us that vegetation is aggressive where in some areas indigenous vegetation takes off without any artificial assistance.
Land use Productivity Visual impacts drainage	Restore to an acceptable alternative use Establish new drainage patterns	Re-contour Encourage establishment of vegetation	Progressive rehabilitation of site allows for resource allocation to be included in the day to day activities of the operation

Table 4: Spoils heap

ISSUES	OBJECTIVES	CONTROL
Physical Stability Dust Erosion drainage	stable surfaces avoid failure and slumps control sediments flow	site selection heap design cap and re-vegetate control drainage
Chemical Stability metal leaching AMD	Clean water by: control reactions control migration collect and treat	cover to control reactions form wetlands divert run-off collect and treat affluent monitor
Land use productivity visual impacts	restore to appropriate land use	Re-contour, cap and establish vegetation Flood and form wetland

Table 5: Water Management

ISSUES	OBJECTIVES	CONTROL
Physical Stability dam walls structures pipelines ditches settling ponds erosion	long term stability and safety of structures flood capacity prevent blockage prevent erosion allow for free passage of water	breach dam remove structures plug intakes and decants fill in ditches provide for long term maintenance monitor
Land use	identify long term use of water reservoirs in line with agrarian reforms	stabilise and maintain dam and establish erosion resistant drainage

Table 6: Infrastructure

ISSUES	OBJECTIVES	CONTROL	RESOURCES
Physical Stability buildings equipment roads helicopter pad	make area safe with controlled access	Determine fate of infrastructure with local government and local communities	Non required if infrastructure will be handed over to interested stakeholders
Chemical Stability fuel and chemical storage fuel and oil spills	make secure and safe	Remove all unwanted materials Treat contaminated soils or dispose in approved site as per EMP	
Land use alternate land use productivity visual impact	Return to appropriate land use	This mainly concerns the processing site where the entire infrastructure will have to be dismantled Remove entire foundation and re-contour Restore natural drainage and revegetate	Resource allocation for this activity is substantial. However, this can be offset by sale salvaged equipment including conveyor belts, motors etc.

Table 7: Socio-economic Issues

ISSUES	OBJECTIVES	CONTROL
Workforce	Re-employment Relocation	Assistance in re-deployment and re-location
Local communities	Stable economy Good health Education facilities	Regional development plan Develop local self-sustainable enterprise Establish communication with local leadership as to services such as continued power and water supply.

4 MINE CLOSURE ISSUES AT MARANGE DIAMOND PROJECT

This section examines the aspects of mine closure pertaining to the envisaged project. It deals with each section/area that will be constructed and highlights issues of concern.

4.1 Spoils Heap

The spoils heap will need to be re-vegetated on mine closure. Re-contouring of sands to encourage local vegetation to take off is encouraged. A monitoring regime for possible acid mine drainage should be established.

4.2 Waste Rock Dumps

Waste rock dumps should be progressively profiled as dumping is taking place. Around the dumps at the bottom, a safety ramp should be constructed. This will assist to arrest any loose rock that might dislodge and fall from the top or side of the dump. Natural vegetation should be allowed to invade the dumps.

4.3 Open Cast Pits

Mining pits poses one of the biggest challenges at any operation. Pits could be flooded with water with the intention of setting up an irrigation project or water reservoir for the local communities. This, however, entails the need to construct new infrastructure capable of handling this new challenge. Besides irrigation, other activities for future consideration would be recreational facilities and commercial fishing. But given the size of the pits, this might not be a suitable option. We suggest therefore that the pits be fenced off in such a manner that animals or people do not inadvertently fall into them. There should, nevertheless be a smooth access to the bottom of the pit in the event that water accumulates therein.

4.4 Mine Compound

Consultation with the local leadership and employees should be done to ensure that no infrastructure is unnecessarily destroyed. Should houses remain intact these may go a long way in complementing Government efforts in the house for all projects.

4.5 Office Block

The offices and other infrastructure in the vicinity would be ideal for some kind of vocational training. This will need to be identified as the need approaches. The mine should however, clean up all oil spills and ensure that no waste contaminated with hazardous materials such as oils are in place. These should be disposed of appropriately as identified in the mine environmental management plan (EMP).

4.6 Plant Area

Since no more mining activities will be envisaged, the entire infrastructure relating to the plant will need to be dismantled. The infrastructure related to mill parts including Conveyor belts, motors etc should be dismantled with care as they, on resale, may offset a substantial amount of the cost of rehabilitation of the plant area.

After dismantling, the entire area should be ripped to encourage vegetation growth and restoration of natural drainage. This ideally could be done during the rainy season.

4.7 Human Resources

The mine should establish a mechanism in which employees are made aware of the inevitable in terms of mine closure after exhaustion of ore reserves. Re-deployment and

assistance in re-location should be considered. Resettlement in nearby areas should be facilitated by management in consultation with the local traditional leadership.

4.8 Utilities

The continued use of utilities such as power and piped water and maintenance hence sustainability of same should be encouraged through engagement of both local government and traditional leadership.

4.9 Overall Sustainability

The proponent is advised to engage with the Mutare Rural District Council and the local leadership in identifying some other projects other than mining that could outlive the mining project. In doing so the continued use of utilities and the benefits of the cash economy will continue to be enjoyed by the community well after mine closure.

4.10 Helicopter Landing Pad

The proponent should rip off the entire pad and re-contour the area and establish natural drainage. The continued use of the pad should however, be established through dialogue with interested parties.

5. CONCLUSION

The mine closure plan for the Marange diamond project should be viewed as a live guiding document that needs subsequent reviews as the project comes to life. The infrastructure, particularly houses should be maintained regularly as their value appreciate with time.

Dialogue between the mine and interested stakeholders must be opened and maintained. Financial resources must be put aside not only for demolition work but also for demonstrating that a walk away scenario could be achieved particularly in terms of open pits and spoils heaps. It is the prerogative of the proponent to come up with its own form of financial surety to cover the technical and financial obligations at mine closure. It must be noted that while there is no legislation to ensure financial guarantees for mine closure at the moment, it is only a matter of time before such legislation is put in force. However, given the current hyper-inflationary environment, the form of the surety needs to be carefully identified.